(12) UK Patent Application (19) GB (11) 2 263 088 (13) A

(43) Date of A publication 14.07.1993

(21) Application No 9224149.6

(22) Date of filing 18.11.1992

(30) Priority data
(31) 9200346 (32) 09.01.1992 (33) GB

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(51) INT CL[5]
B60K 17/00, B62D 53/02, B66F 9/06

(52) UK CL (Edition L)
B7H HA HDT H510 H518 H576 H620 H741 H744 H745 H751

(56) Documents cited
GB 2234214 A GB 2208500 A US 3225949 A
US 2986295 A

(58) Field of search
UK CL (Edition L) B7H HA HDT HDV HFJ
INT CL[5] B60K 7/00 17/00 17/16 17/356, B62D 53/02, B66F 9/06
Online database: WPI

(54) Narrow aisle forklift truck with differential mechanism

(57) A narrow aisle forklift truck is enabled to turn at extreme steering angles and minimise or avoid tyre scrub or the like by having a differential mechanism D allowing the driven wheels 14 to turn at different speeds, and arranging for the maximum steering angle to result in intersection of the axes A1, A2 of the front and rear wheels at a point lying within the track of the driven wheels. The differential may be mechanical with input from a single motor or two electric motors, one for each wheel, may be wired in series to provide a differential effect. Alternatively, a pair of hydrostatic motors may be used.

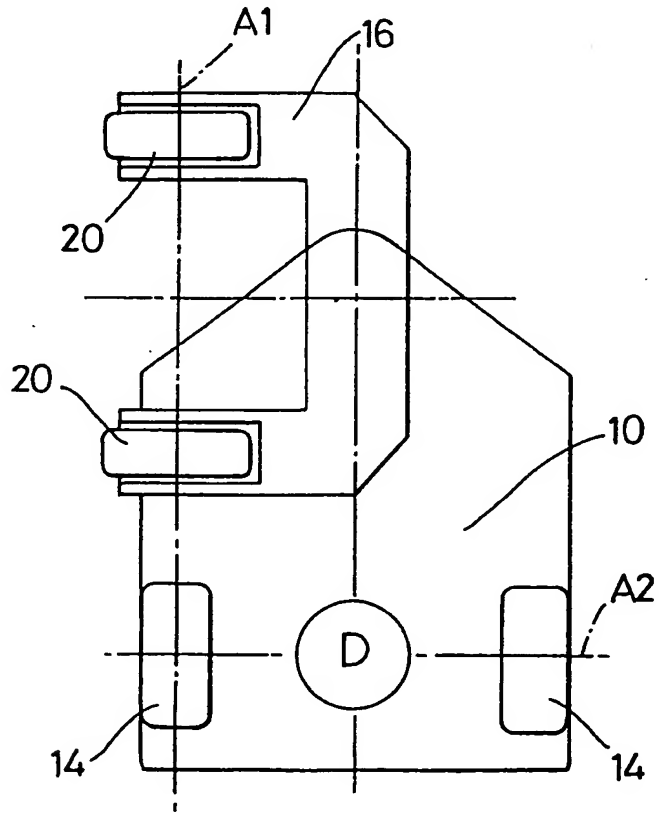

Fig. 2

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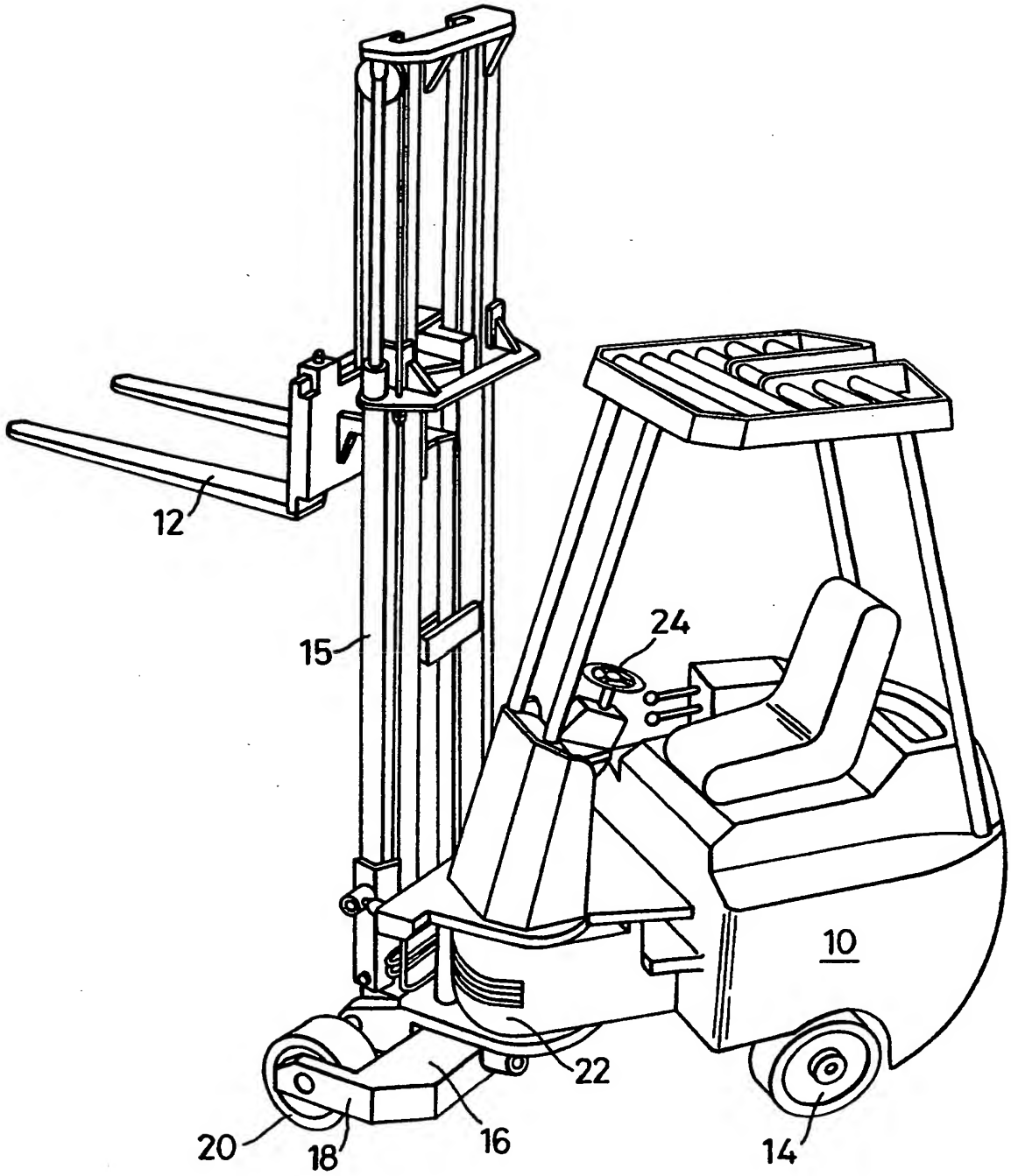

Fig. 1

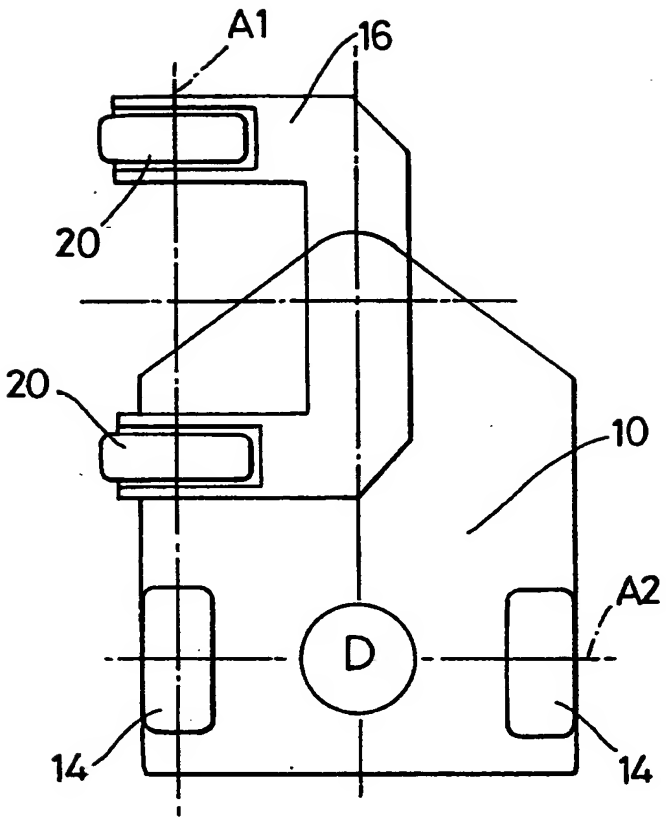

Fig. 2

IMPROVEMENTS RELATING TO FORKLIFT TRUCKS

This invention relates to forklift trucks of a kind designed for use in narrow aisles of warehouses and the like, where the truck is to insert loads in, and remove loads from, the face of a stack, in a direction transverse to the length of the aisle, that is at right angles to that face.

All truck design must be a compromise between considerations of cost, load carrying ability, speed and stability in use, to name but four aspects which the designer takes into account. The conventional design solutions for the present purposes include making the truck of two sections which are pivoted together centrally of the length of the vehicle, with two front wheels supporting the section carrying the mast and forks and hence load, and two rear wheels supporting the section carrying the drive motor and the storage batteries used for the propulsion system.

Particular problems arise in connection with instability, tyre wear, and potential skidding and loss of control particularly near or at maximum steering angle when the front axle extends at right angles to the rear axle. Some convention solutions have included the use of driven front wheels and a trailed rear section, but this necessitates a certain minimum size for the front wheels and in effect makes them larger than would otherwise be the case which has a deleterious effect on stability. Four wheel drive has been suggested, but this carries an additional penalty in terms of weight and cost. Another solution to be found in the published specification of application PCT/GB19/01050 employs independent drive to the two rear wheels by way of separate motors with means arranged to cause the inner wheel - that is the one nearest to the centre about which the truck turns - to be slowed as the steering angle increases, stopped when the steering angle reaches appropriate value, and then reversed at maximum steering angle. This can provide an ideal solution in terms of

tyre wear and skidding but with a penalty in cost because of the use of two motors and a control gear for automatically varying speed and direction of drive.

It is generally known in motor land vehicles having a relatively small steering angle at maximum, for example in automobiles, to use rear wheel drive with a differential mechanism in the drive, allowing the two wheels to turn at different rates: as the vehicle travels forwardly along a left curve the left hand wheel nearest the centre of turning travels slower, and this completely avoids wheel slip or skidding. However, the present inventor believes that such differentials have not been employed in the rear wheel drive of forklift trucks of this kind and has experimented with their use, but found them unsatisfactory and that they in fact led to further instability.

The present invention is based on the discovery that the differential mechanism is, after all, useful in specific selected circumstances and then provides an extremely satisfactory solution which may be an improvement over anything at present known at least in terms of the four considerations mentioned earlier herein.

According to the invention, a narrow aisle forklift truck has a centre pivot dividing the truck into front and rear sections, the mast and forks are mounted on the front section supported by a pair of undriven wheels and the rear section is mounted on a pair of driven wheels connectable to drive means characterised in that a line drawn through the axes of the front wheels and a line drawn through the axes of the rear wheels intersect at maximum steering angle at a point lying between the track of the rear wheels and in that the drive means include a differential gear.

The word track is used to mean the dimension between the outsides of the said wheels.

In some cases the point of intersection may lie

slightly nearer the centre of the truck, for example since each wheel has a finite width, a centre point on the wheel may be taken as the point of intersection at maximum steering angle. Where this is done, at maximum steering angle the truck will effectively pivot about that point of intersection. Where the point of intersection lies on the outside of that wheel, i.e. nearer the centre of pivoting. that again will be the pivot point at maximum steering angle, but in both of these cases tyre scrub and wear will be relatively low and probably at an acceptable rate.

When the intersection lies between the wheels the inner wheel will turn slowly relative to the outer wheel as the vehicle drive continues.

When the intersection lies within the width of the driven wheel which is nearest to the centre of pivoting the differential will allow that wheel to remain stationary in the sense that it does not turn about its driven axis, although that wheel may pivot about the point of contact with the ground at such time. When the intersection point lies between the wheels, the wheel nearest to the centre of pivoting will turn about its driven axis relatively slowly whilst the wheel more remote from the pivot centre will turn faster.

The differential may be a mechanical one, in which case a single motor drive may be employed as an input to the differential with a pair of half-shafts driving the respective wheels. Alternatively an electric differential can be employed using two electric motors. one for each driven wheel, wired in series. The motors may be 24 volt with a 48 volt supply. Alternatively hydrostatic motors may be used arranged in the same way. When the truck turns sharply the wheels are effectively driven at different speeds by these means.

In the accompanying drawings.

Figure 1 is a perspective view of a typical narrow aisle forklift truck; and

Figure 2 is a diagrammatic plan illustrating an intersection point.

Turning first to Figure 1, the truck comprises a body 10, lift forks 12 mounted on a carriage which can be elevated and lowered on a mast 15. a front sub-frame 16 with arms 18 carrying front wheels 20, and a main king pin or pivot axis in the part 22 which couples the front sub-frame to the main body part 10. The truck has a pair of rear wheels 14 which are driven. with an interposed differential as explained. The body part 10 carries the driver and has a steering wheel 24.

Turning now to Figure 2, this drawing shows the body parts in an extreme steered angle position and in this case the axis A1 of the front wheels 20 intersects the axis A2 of the driven wheels 14 at a point in the centre of the ground contacting area of the wheel 14 which is nearest the centre about which the vehicle is turning. As mentioned, that point may lie anywhere within that wheel at maximum steering angle including (at its extreme position) at the face of the wheel nearest to the centre about which the vehicle is turning. The letter D on Figure 2 indicates the position of the mechanical differential if used, although the electric possibility also exists as mentioned earlier herein.

CLAIMS

1. A narrow aisle forklift truck having a centre pivot dividing the truck into front and rear sections, the mast and forks are mounted on the front section supported by a pair of undriven wheels and the rear section is mounted on a pair of driven wheels connectable to drive means characterised in that a line drawn through the axes of the front wheels and a line drawn through the axes of the rear wheels intersect at maximum steering angle at a point lying between the track of the rear wheels and in that the drive means include a differential gear.

2. A truck as claimed in Claim 1 wherein the differential gear is a mechanical arrangement allowing the wheel nearer the centre about which the vehicle turns to be driven more slowly than the outer wheel.

3. A truck as claimed in Claim 1 wherein the differential is electric comprising a pair of electric motors, one connected to drive each driven wheel, and wired in series.

4. A truck as described in Claim 1 wherein the differential is hydrostatic comprising a fluid pump and fluid motors for each wheel.

Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
GB 9224149.6

Relevant Technical fields

(i) UK Cl (Edition L) B7H (HA, HDT, HDV, HFJ)

(ii) Int Cl (Edition 5) B60K 7/00,17/00,17/16,17/356; B62D 53/02; B66F 9/06

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASE: WPI

Search Examiner

J L TWIN

Date of Search

COMPLETED
12 JANUARY 1993

Documents considered relevant following a search in respect of claims 1

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
A	GB 2234214 A (TRANSLIFT)	1, 3
A	GB 2208500 A (TRANSLIFT)	1
X	US 3225949 (ERICKSON ET AL) see eg column 2, line 60 - column 3, line 15; column 5, lines 23-55	1, 2
X	US 2986295 (SHAFFER) see eg column 6, lines 33-55	3

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family, corresponding document.

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).